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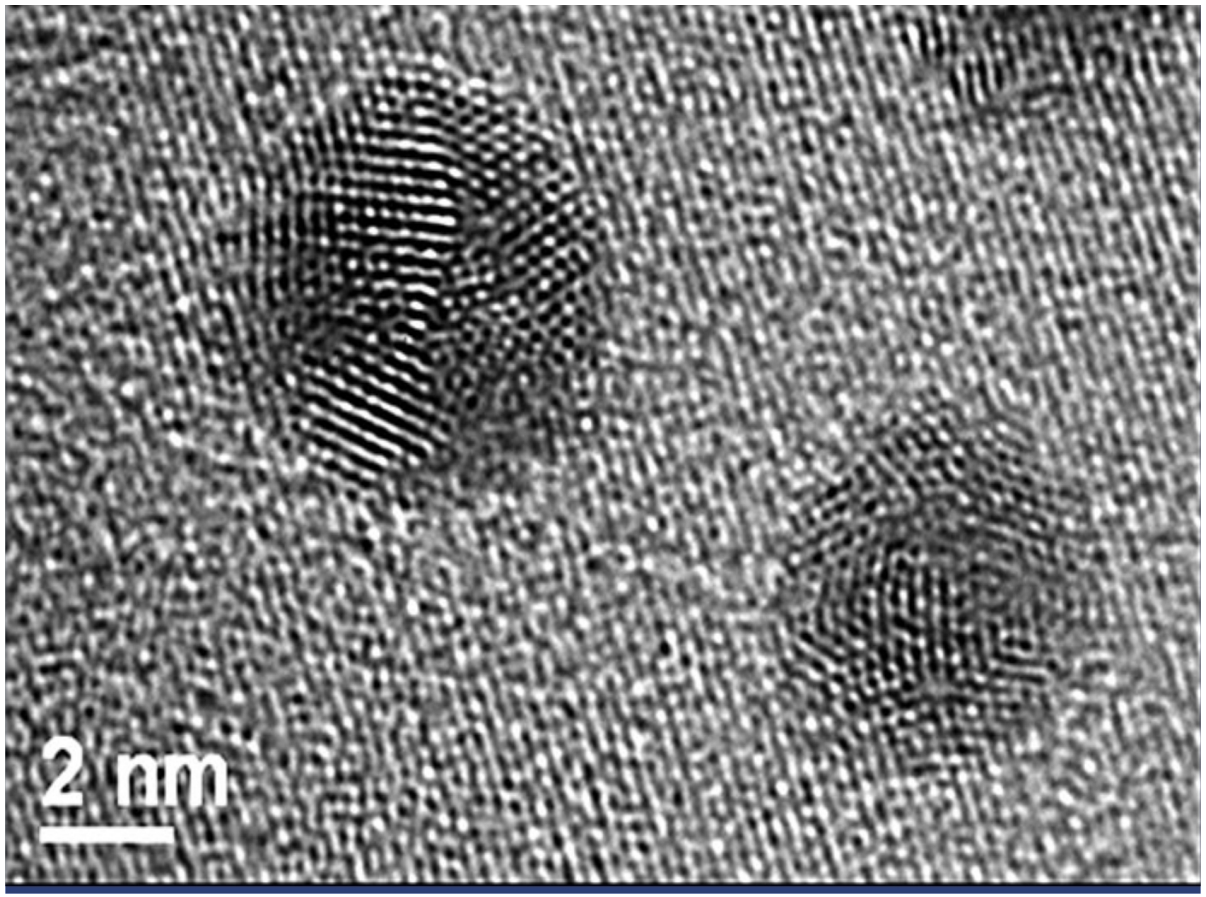
NANOMEX

National Nanotechnology Initiative

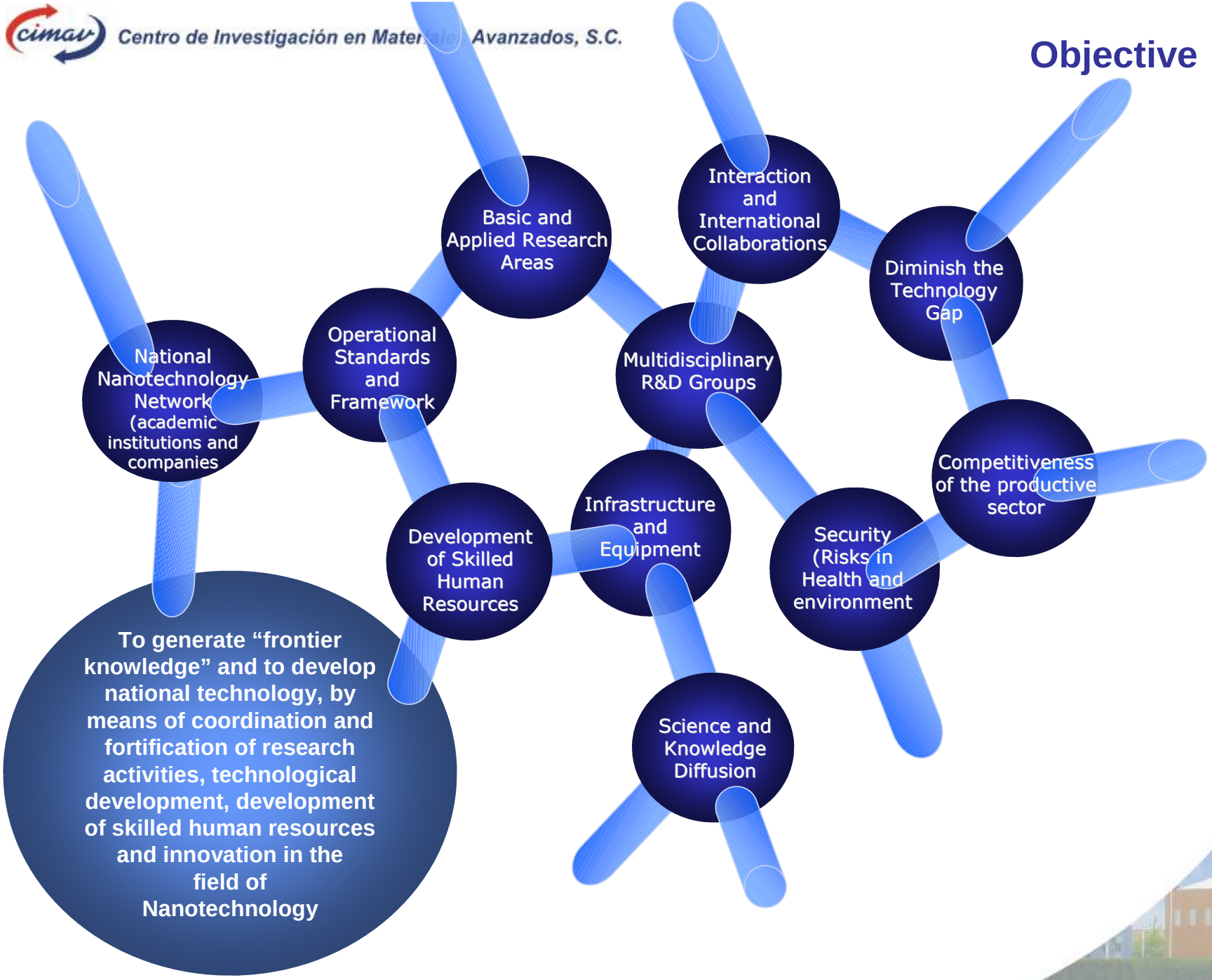


Washington, D.C. February 2008

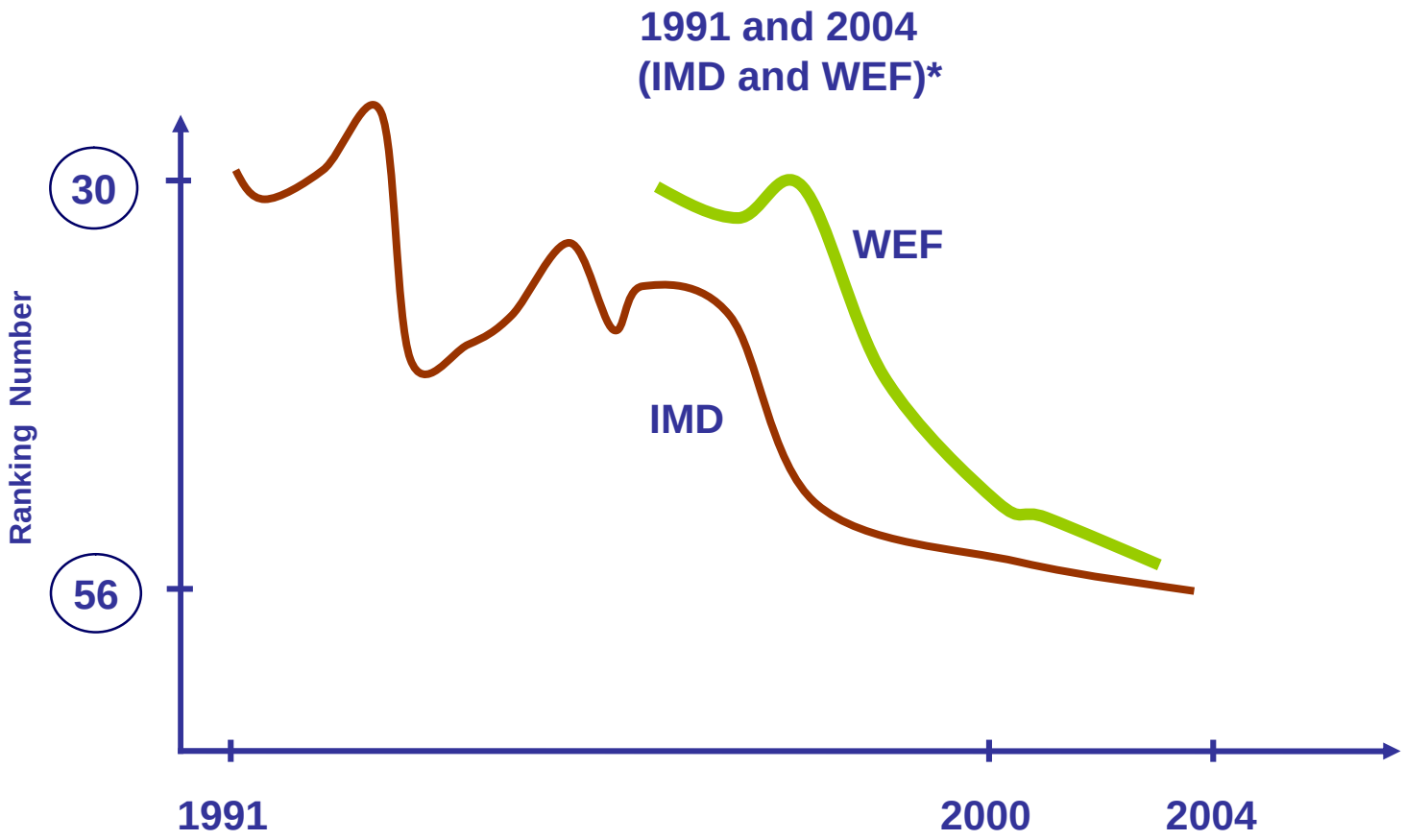
www.cimav.edu.mx

Centro de Investigación en Materiales Avanzados, S.C.

Objective



Mexico's Competitive Ranking

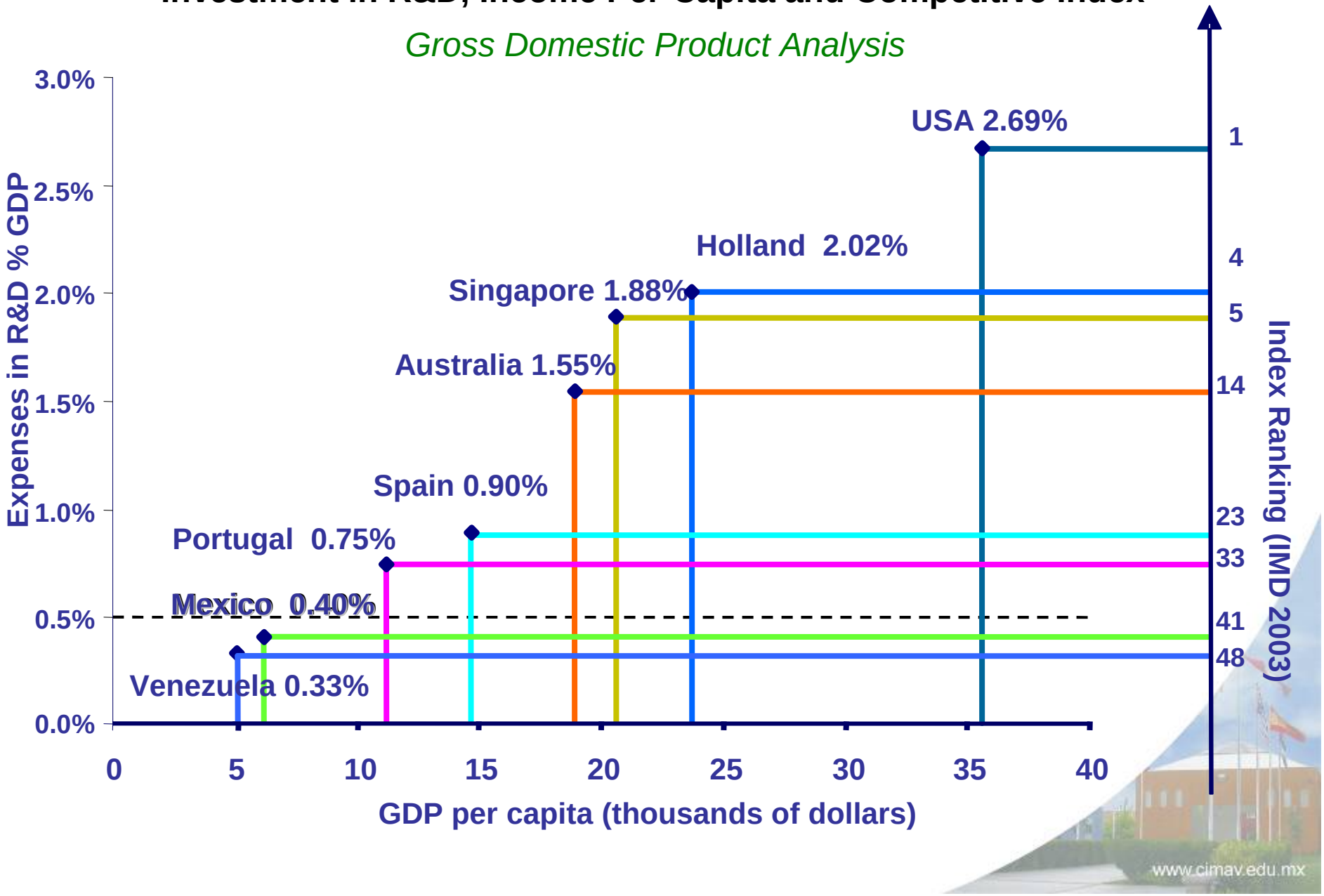


* Source:
IMD : International Institute for Management Development
WEF : World Economic Forum

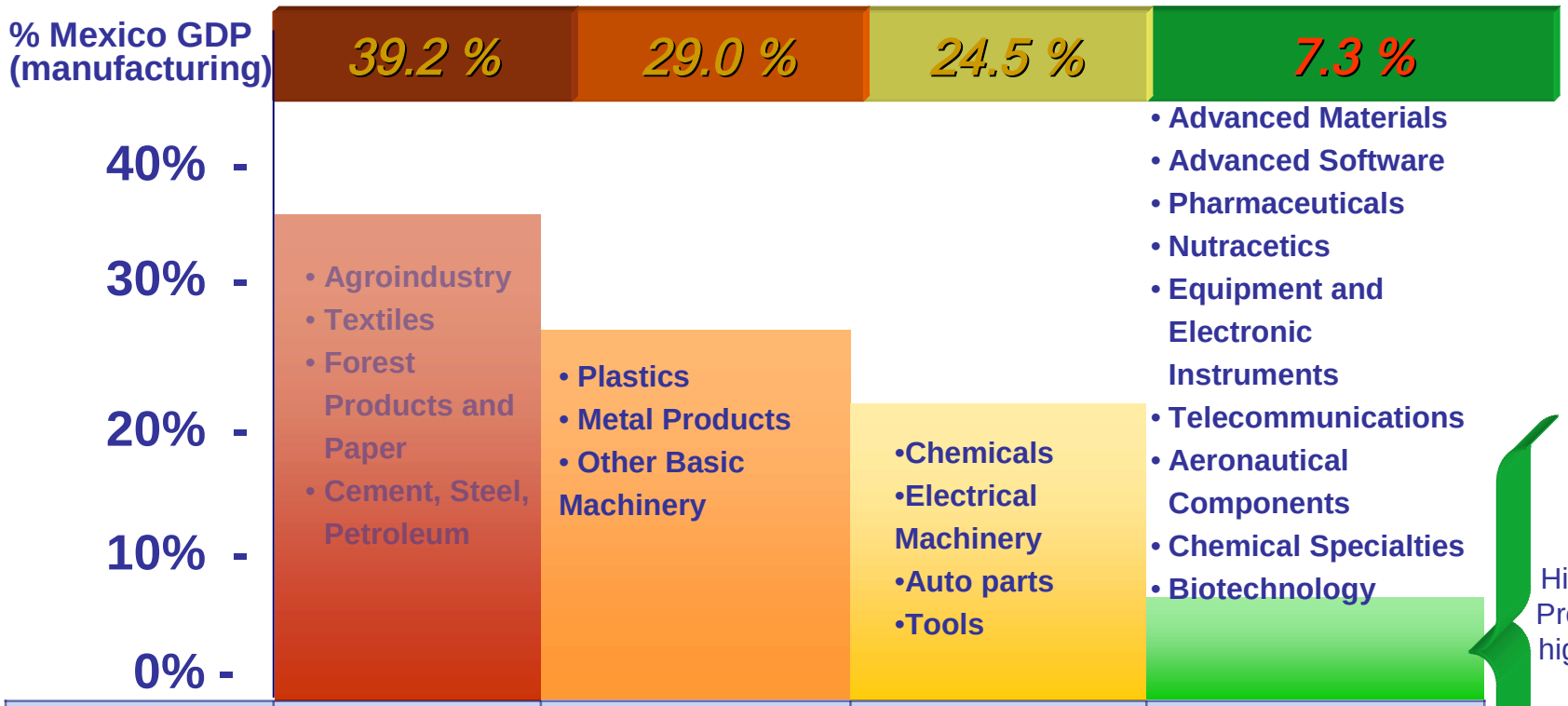
National Overview

Investment in R&D, Income Per-Capita and Competitive Index

Gross Domestic Product Analysis



National Overview



Market Price: Dls/kg	*Low <$1*	*Medium - Low <$10*	*Medium - High <$100*	*High <$1000*
Average Salary (Dls/hr)	*$3.00*	*$6.00*	*$12.00*	*$24.00*
Productivity (Dls/hr)	*$10*	*$40*	*$160*	*>$600*

Nanotechnology R&D in Mexico

- High level R&D groups with international recognition
- Isolated and dispersed efforts and resources
- Marginal results with practically null results
- Rising costs associated with R&D activities

Loss of Opportunities and Resources

Focus and Model

- *Generating "frontier knowledge"*
- *Creating new research infrastructure*
- *Generating solutions to technology, products, processes and equipment*
- *Creating new post graduate programs and developing skilled and qualified personnel*

- *Identification of necessities and opportunities*
- *Integrating business cases*
- *Investment in new solutions and business ventures*
- *IP and technology transfer*
- *Incorporation of skilled human resources*

- *Providing economic support*
- *Providing economic/tax incentives*
- *Facilitating standards and regulations*
- *Access to federal procurement systems*
- *Facilitating venture capital and venture funds through collaboration models*

Focus and Model

Results

- Knowledge
- Specialized Human Resources
- Patents
- Industrial Competitiveness
- Innovation of products and processes
- High Paying Wages, etc.

Orientation

- Innovation
- Regional Development

Baseline

- Research and Development Technological Network
- Development of Skilled Human Resources

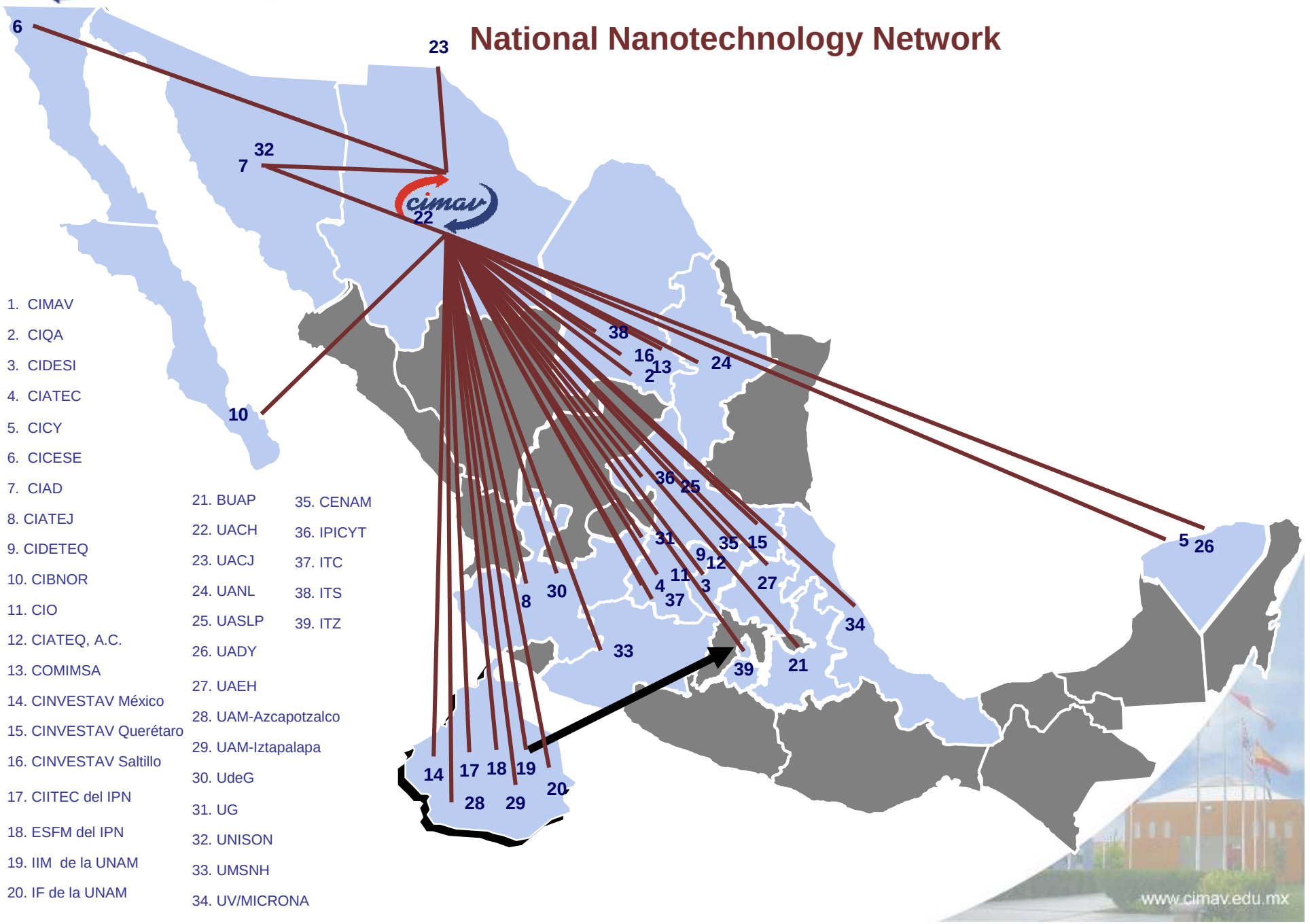
Focus and Model

Values and Principles

1. Outstanding Research
2. Postgraduate and Development of Skilled Human Resources with International Quality
3. Multidisciplinary Team Focused Toward Results
4. ***Focused Research Programs with the Possibility of Generating Deliverables within 5 Years***
5. Sharing of Research Infrastructure and Resources Among Nanotechnology Network
6. Evaluation of Proposals and Initiatives or New Infrastructure by Ad-Hoc Committees Integrated by Distinguished Members of the Academic / Research Sectors
7. ***Allocation of Resources by Pre-Competitive Processes with Quality and Feasibility Criteria***
8. ***Periodical Evaluations to Measure Advances and Accomplishments by Independent Evaluators***
9. Collaborative Team Based Approach of Research Activities with the Industrial Sector Network, for the Identification of Market Requirements and Opportunities
10. Metric Based Indicators that will Help Evaluate Programs and Measure the Benefits and Results Obtained

Operation

National Nanotechnology Network



1. CIMAV
2. CIQA
3. CIDESI
4. CIATEC
5. CICY
6. CICESE
7. CIAD
8. CIATEJ
9. CIDETEQ
10. CIBNOR
11. CIO
12. CIATEQ, A.C.
13. COMIMSA
14. CINVESTAV México
15. CINVESTAV Querétaro
16. CINVESTAV Saltillo
17. CIITEC del IPN
18. ESFM del IPN
19. IIM de la UNAM
20. IF de la UNAM
21. BUAP
22. UACH
23. UACJ
24. UANL
25. UASLP
26. UADY
27. UAEH
28. UAM-Azcapotzalco
29. UAM-Iztapalapa
30. UdeG
31. UG
32. UNISON
33. UMSNH
34. UV/MICRONA
35. CENAM
36. IPICYT
37. ITC
38. ITS
39. ITZ

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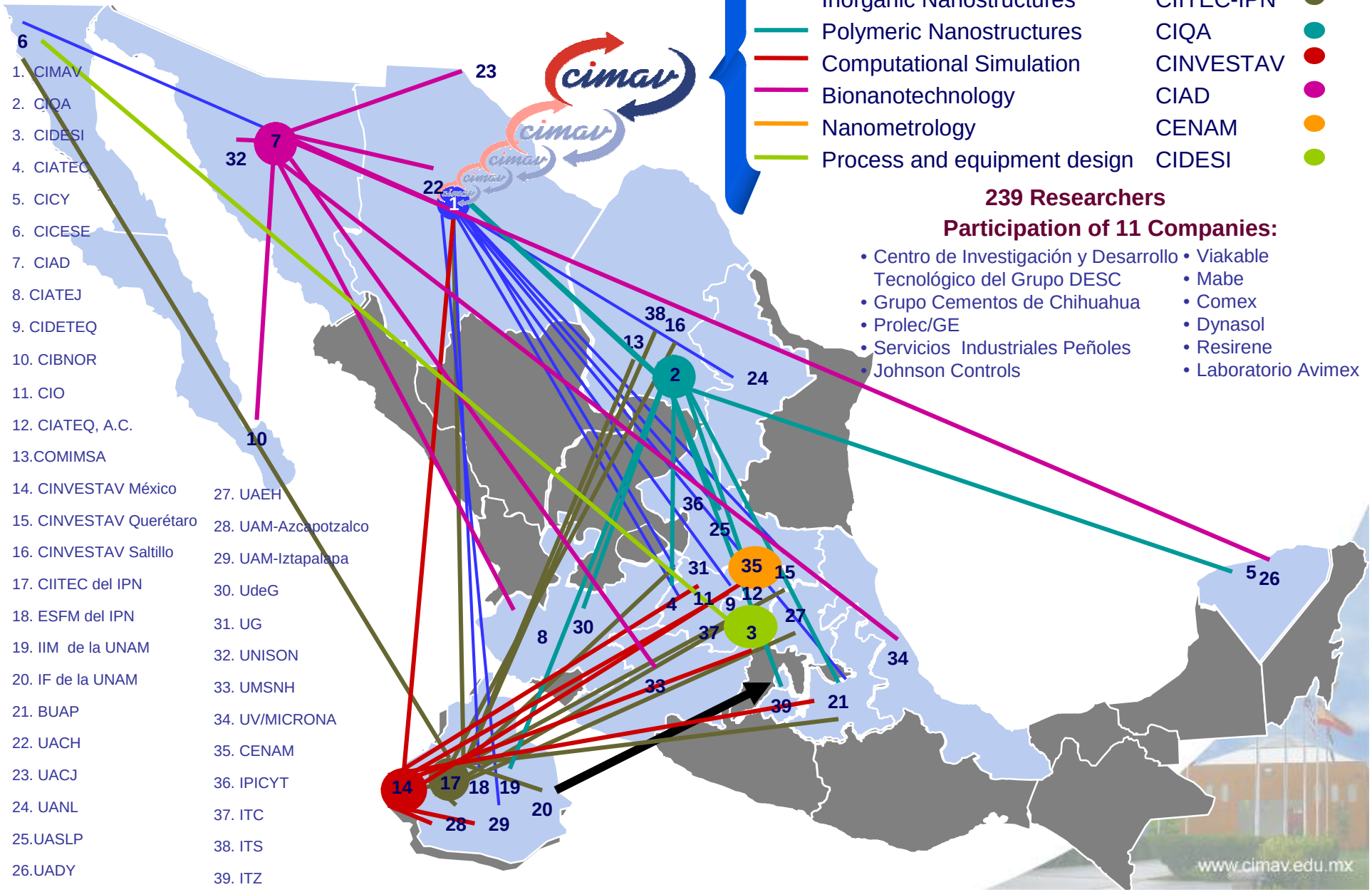
Operation

National Nanotechnology Network

Key Competency Areas	Key Area Leaders
Nanoparticles	CIMAV
Inorganic Nanostructures	CIITEC-IPN
Polymeric Nanostructures	CIQA
Computational Simulation	CINVESTAV
Bionanotechnology	CIAD
Nanometrology	CENAM
Process and equipment design	CIDESI



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31. UG
32. UNISON
33. UMSNH
34. UV/MICRONA
35. CENAM
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38. ITS
39. ITZ

239 Researchers

Participation of 11 Companies:

- Centro de Investigación y Desarrollo Tecnológico del Grupo DESC
- Grupo Cementos de Chihuahua
- Prolec/GE
- Servicios Industriales Peñoles
- Johnson Controls
- Viakable
- Mabe
- Comex
- Dynasol
- Resirene
- Laboratorio Avimex

International Collaborations

International Institutions

1. Arizona State University (ASU), Tempe, Arizona, USA **(Nanotechnology Cluster with an 8 million dollar investment)**
2. Center for Integrated Nanotechnologies (CINT), Albuquerque, and Los Alamos, New Mexico, USA jointly operated by Los Alamos National Laboratory, Los Alamos, New Mexico, USA; Sandia National Laboratories, Albuquerque, New Mexico USA
3. University of Texas at Austin; Austin, Texas, USA
4. State University of New York at Albany; Albany, New York, USA
5. National Center for Learning and Teaching in Nanoscale Science and Engineering; Chicago, Illinois, USA
6. Lawrence Berkeley National Laboratory, Berkeley; University of California, Berkeley, California, USA
7. Mexico – USA, Bi-National Sustainability Laboratory (BNSL), Santa Teresa, New Mexico, USA
8. Chalmers University of Technology, Sweden
9. University of California, Santa Barbara, USA
10. University of Sheffield, United Kingdom
11. University of Limoges. France

Key - Technology Competencies

Key Technology Competences	Institution
Nanoparticles synthesis	CIMAV, CIDETEQ, UANL, UASPL
Nanostructures self assembly	CIMAV, IPN, UAG, UASPL, CIDETEQ
Functional nanomaterials and its applications	CIMAV, CIQA, CIAD, CINVESTAV Saltillo, CIDETEQ,
Mechanical / chemical synthesis methods	UASPL, CIMAV, CINVESTAV Querétaro, COMIMSA, CIDESI
Polymeric structures	CIQA, CIATEC, CICY, ITZ, UDG, IIM UNAM
Synthesis of ceramic structures	CIITEC-IPN, CINVESTAV Saltillo, UAM Azcapotzalco, IF UNAM
Carbon nanotubes and its applications	CIMAV, CIQA, CIAD
Advanced materials for glass and cement	CIITEC-IPN, UACH, CIMAV, CIDESI
Advanced materials for packaging	CIQA, CICY, UDG
Electrical and mechanical properties of nanostructures and nanocomposites	CINVESTAV Querétaro, CIITEC-IPN, CIMAV, CIATEC
Physicochemical characterization of nanoparticles and nanostructures	CIITEC-IPN, CIQA, CIMAV, CIATEJ, CIDESI, IIM UNAM, CINVESTAV Saltillo, CINVESTAV Querétaro
Biocompatible nanostructures	CIBNOR, CIAD
Nanobiotechnology	CIAD, UACH, UNISON, UACJ
Nano / macro interfaces and metallic surfaces	CIATEQ, UAM, CIITEC-IPN
Chemical reactivity	CIMAV, CIATEQ
Computational simulation and modeling	CINVESTAV México, CINVESTAV Querétaro, BUAP, CIMAV, UAM Azcapotzalco, UAM Iztapalapa, UG
Nanometrology	CENAM

Opportunity areas identified and analyzed to start the initiative

Nanoparticles

Scientific – Technical Platform: Sol- Gel
Scientific –Tecnological Platform: Physical Method (Milling)
Scientific –Tecnological Platform: High Temperature (Vapor Condensation)

Bionanotechnology

Scientific – Technical Platform: Microemulsion/Sol Gel
Scientific – Technical Platform: Vapor Condensation

Inorganic Nanostructures

Scientific – Technical Platform: Wet Route/Sol Gel
Scientific – Technical Platform: Physical Methods/SPS

Polymeric Nanostructures

Scientific – Technical Platform: Composites
Scientific – Technical Platform: Synthesis

Computational Simulation

Scientific – Technical Platform: Multiscale Systems for the Design and Simulation of Systems that are Related to Nanotechnology

Nanometrology

Scientific – Technical Platform: *Development of National Standards and Measurment Systems for the Assurance of Metrological Measurements*

Processes and Equipment

Scientific – Technical Platform: Design of Processes and Equipment for Synthesis

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Nanoparticles

Scientific – Technical Platform: Sol- Gel

Research Areas by Areas of Competency		Institutions Participants
Nanoparticles CIMAV	• Nanoparticles in industrial catalysis • Synthesis by wet routes • Chemical reactivity • Mechanical synthesis methods • Physicochemical characterization • Environmental applications	**UASLP, CIDETEQ, UANL, CINVESTAV QRO, CIO, ESFM IPN, CIATEC**
Inorganic Nanostructures CIITEC-IPN	• Ceramic structures • Physicochemical characterization • Structural biocompatibility • Nano-micro interfaces • Metallic surfaces • Catalysis	**UAM, CINVESTAV QRO, CIMAV**
Polymeric Nanostructures CIQA	• Electrical and mechanical properties • Functionalization and application • Structure auto assembly	**CICY**
Simulation CINVESTAV MEXICO	• Materiales simulation • Functional molecular nanomaterials • Conceptual and theoretical using DFT • Nanomolecular catalysis • Nanoaggregates • Metallic and molecular	**CIMAV, BUAP, CINVESTAV QRO, CINVESTAV MÉXICO, U DE GUANAJUATO, UAM AZCAPOTZALCO, UAM IZTAPALAPA**
Bionanotechnology CIAD	• Biosecurity • Antiviral • Antibacterial	**UACH, UNISON**
Nanometrology CENAM	• National standards and measuring systems • Certification of reference materials • Development and validation of analytical methods to determine the content of nanomaterials in different matrixes • High reliability tests for products that contain nanomaterials	
Processes and Equipment CIDESI	• Process Modeling • Pilot plants • Measuring equipment • Design of equipment and processes	**CIATEQ**

Products

Academics

Doctors
Masters
Publications
Patents

Markets

Metales
Oxides
Hydroxides

Cu, Ag, Pt, Mg, ZnO, FeO, Al_2O_3, SiO_2, $Mg(OH)_2$, $Fe(OH)_2$, $Sn(OH)_4$.

Applications

•Metallic Particles (steel, aluminum, textile fibers, electrical materials, catalysis, sensors)

•Metallic Oxides (Paints, coatings, cement, ceramics, catalysis, electrical materials, glass, personal care, plastics, polymers, catalysis)

•Hydroxides (Personal care, plastics, food products, packaging)

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Nanometrology

Scientific – Technical Platform: *Development of National Standards and Measurment Systems for the Assurance of Metrological Measurements*

Research Areas by Areas of Competency		Institutions Participants
Nanometrology CENAM	• National standards and measurement systems • Certification of reference materials • Development and validation of analytical methods of the content of nanomaterials in different matrixes. • High reliability tests for products that contain nanomaterials • Inter-laboratory comparisons	
Nanoparticles CIMAV	• Synthesis by wet route • Mechanical methods synthesis • Physicochemical characterization	**CIMAV, UASLP, CIDETEQ, UANL, CINVESTAV QRO, CIO, ESFM IPN**
Inorganic Nanostructures CIITEC-IPN	• Synthesis via vapor condensation • Synthesis by SPS • Synthesis of CNT • Physicochemical characterization	**IPN, CIMAV, INST. FISICA UNAM, CINVESTAV SALTILLO, UNIV. DE GUANAJUATO, UAM AZCAPOTZALCO, CICESE, COMIMSA, UAEH**
Polymeric Nanostructures CIQA	• Microemulsion polymerization • Rheological properties • Mechanical, electrical and optical properties • Extrusion, injection molding, compression molding	**CIATEC, CICY, CIMAV, IIM UNAM, ITZ, UDG**
Simulation CINVESTAV MEXICO	• Simulation of materials • Study and development of biological nanoreactors	**CIMAV, BUAP, CINVESTAV QRO, CINVESTAV MÉXICO, U DE GUANAJUATO, UAM AZCAPOTZALCO, UAM IZTAPALAPA**
Bionanotechnology CIAD	• Functional complexes • Exposure to nanostructured materials • Biosensors • Vaccines	**UACH, UNISON, UACJ, UV-MICRONA, USMNH, UADY, CIBNOR**
Processes and Equipment CIDESI	• Pilot Plants • Measuring equipment • Design of equipment and processes • Equipment calibration • Measuring standards • Automation and instrumentation	**CIATEQ**

Products

Academics

Doctors
Masters
Publication
patents

Markets

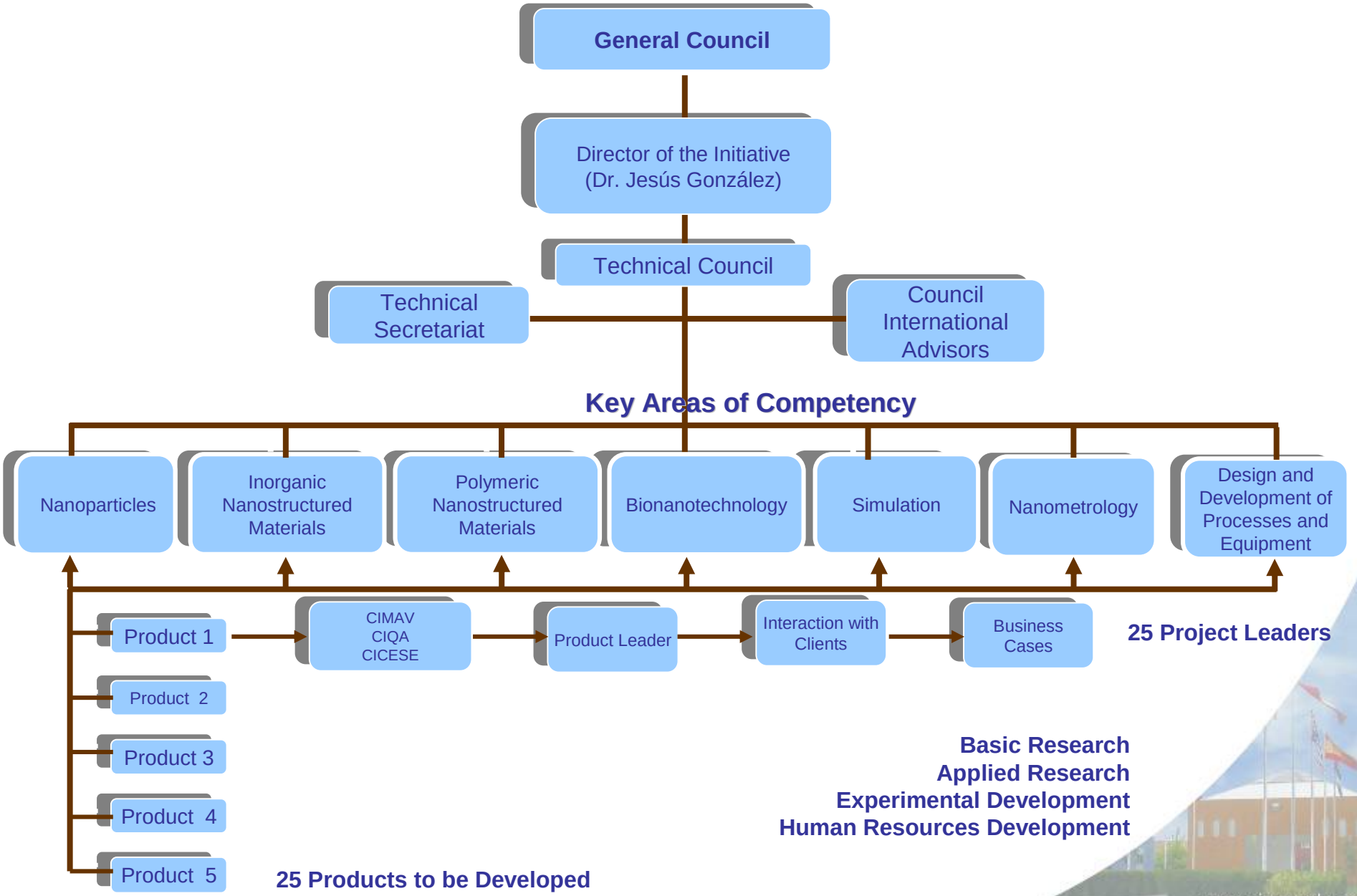
Reference materials for particle size, reference materials for nanomaterials content in different matrixes diffraction gratings to calibrate microscopes, measurement standards calibration, development of methods for the characterization of nanomaterials in industrial products and for personal health care applications

Applications

Measuring equipment, plastics, powder management, measurement standards, reference materials

Operation

National Nanotechnology Network



Results

- Around **150 Ph D´s and 450 masters** graduates in sciences, with an **enrollment** estimated at **550 PhD doctorate students and 1,700 masters**

- More than **1,000 articles in international indexed journals** in 5 years (an average of 200 articles per year)

- Around **200 patent titles or registrations** in 5 years, **7 process and equipment designs** associated to the technology platforms detected in this project, **3 computational programs** for the **simulation** of nanoparticles and nanostructures and **a company** to offer **hardware and software solutions in the design of materials and molecules.**

- Obtain **specific guidelines for intellectual protection** for the commercialization of projects derived from this initiative

- To sign at least **15 agreement with institutions** with recognized **international** prestige, oriented towards the development of joint projects and international cooperation related to the topics.

- To move beyond the 239 actual **researchers** from the **participating** institutions in the network to **more than 400**

- At least **25 products** grouped in 5 families (liquid phase technology, milling technology, high temperature technology, nanostructured materials and technology from nanocomposites) oriented toward necessities and exportation of Mexico's industrial market **with potential sales** starting on the sixth year in the order **of 100 to 150 millions de dollars annually.**

- Create new **state of the art infrastructure** in the different institutions that participate in the network (laboratories, buildings, workshops, etc.).

- At least 5 cases of new business generated from the products developed by the institutions participating in the network.

- Generate at least **500 scientific and technological products** to diffuse the social and economical impact of nanotechnology of nanotechnology (reports, books, press releases, radio programs, and television, etc.).

Phases

Phase	Activity	Period
1st phase	Conceptualization and design	2007
2nd phase	Implementation, operations expansion and technology transfer of the first projects	2008 – 2010
3rd phase	Fortification and consolidation of the network. Commercialization of the first products.	2011

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Some results on nanotechnology

Based on work made at CIMAV

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CIMAV

(Advanced Materials Research Center)

www.cimav.edu.mx

Synthesis and Characterization of Magnetic Materials

Synthesis and magneto-structural study of $Co_xFe_{3-x}O_4$ nanoparticles

Journal of Magnetism and Magnetic Materials 294 (2005) e33–e36

Magnetite-cobalt ferrite nanoparticles for kerosene-based magnetic fluids

Journal of Magnetism and Magnetic Materials 294 (2005) e37–e41

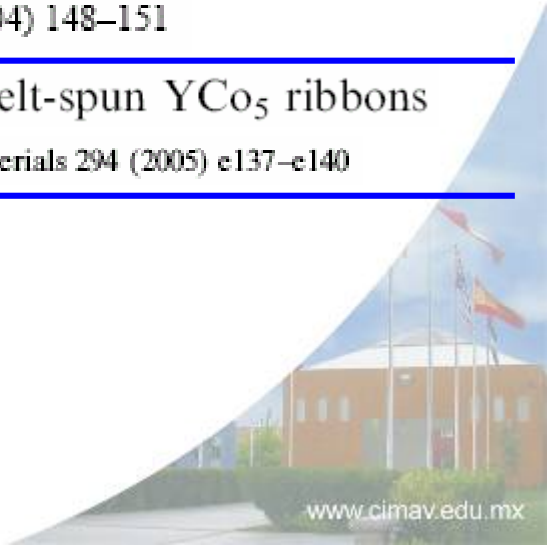
Magnetic nanocomposites: preparation and characterization of Co-ferrite nanoparticles in a silica matrix

Journal of Alloys and Compounds 369 (2004) 148–151

Magnetic and structural study of melt-spun YCo_5 ribbons

Journal of Magnetism and Magnetic Materials 294 (2005) e137–e140

- ***Mossbauer spectroscopy***
- ***Magnetization hysteresis loop***
- ***Saturation Magnetization***
- ***Remanent magnetization***



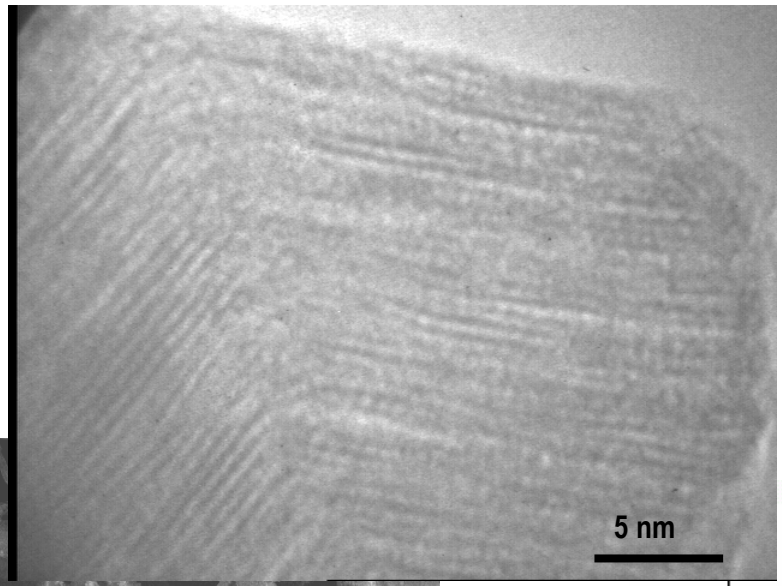
Magnetic Fluids made by Nanoparticle Suspension

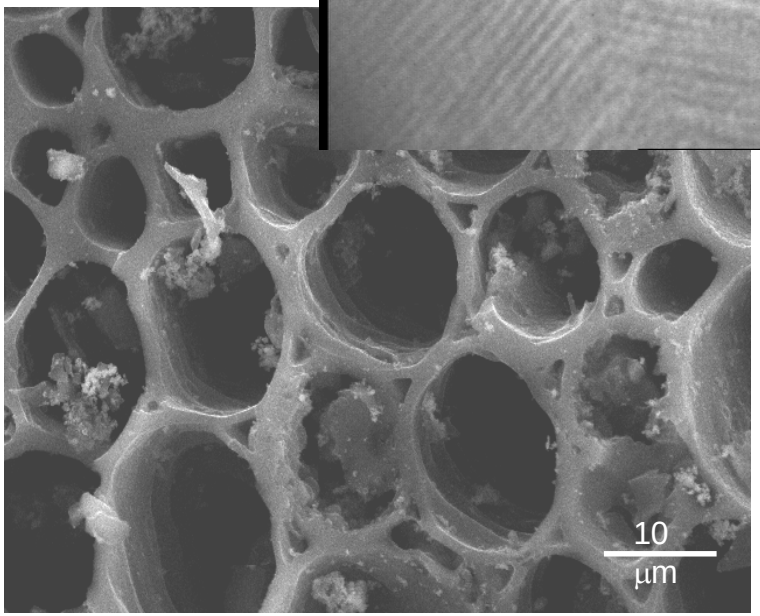
Without magnetic field

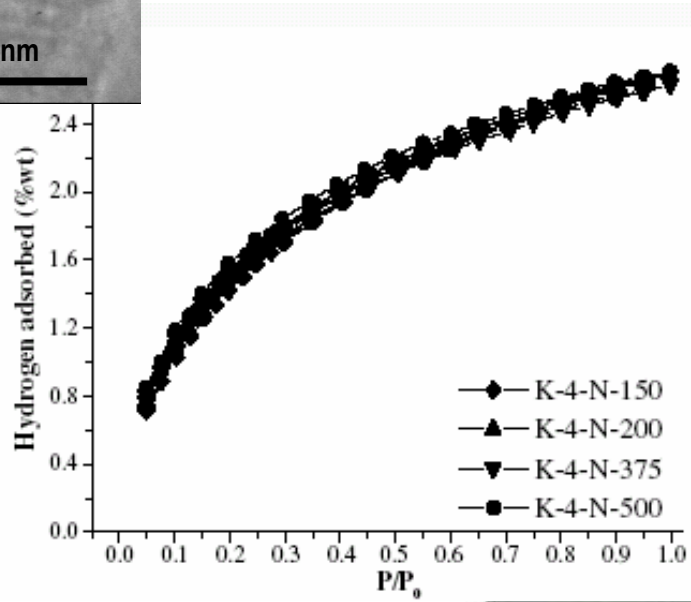
Under magnetic field

Stability of magnetic fluid is higher than two years

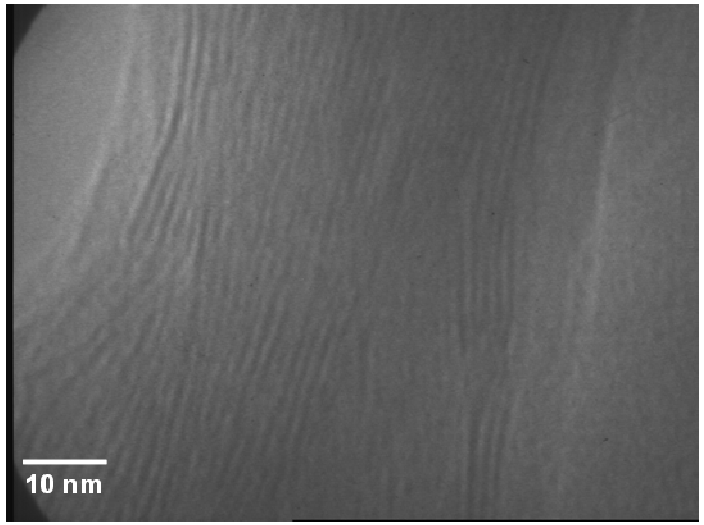
Development of Hydrogen storage materials based on Carbon Molecular Sieves

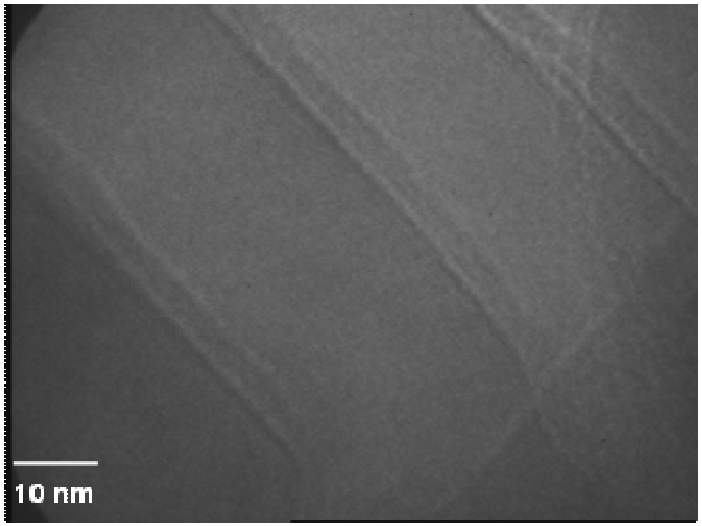




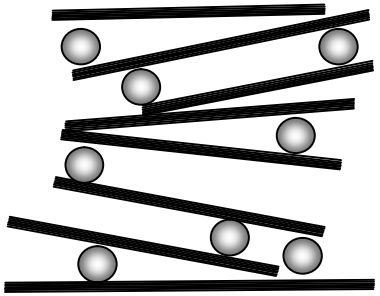


Nano-assembled Clays for Catalysis or Gas Storage





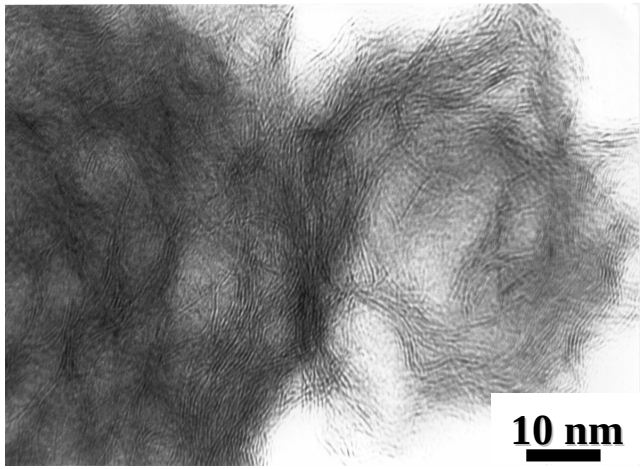
+ Silica Nanoparticles

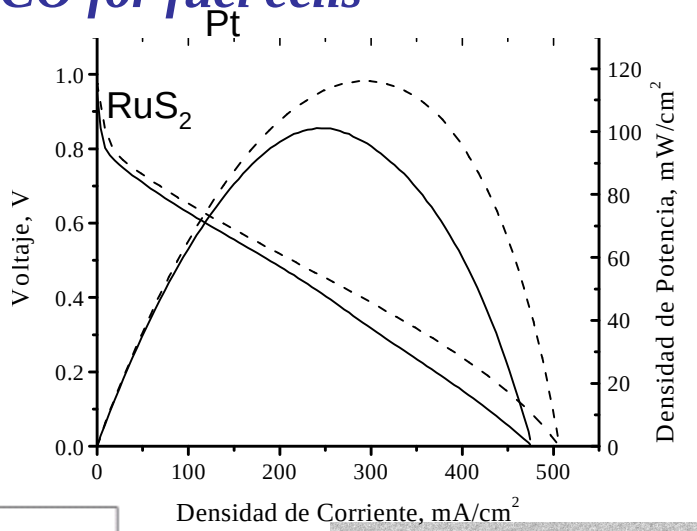


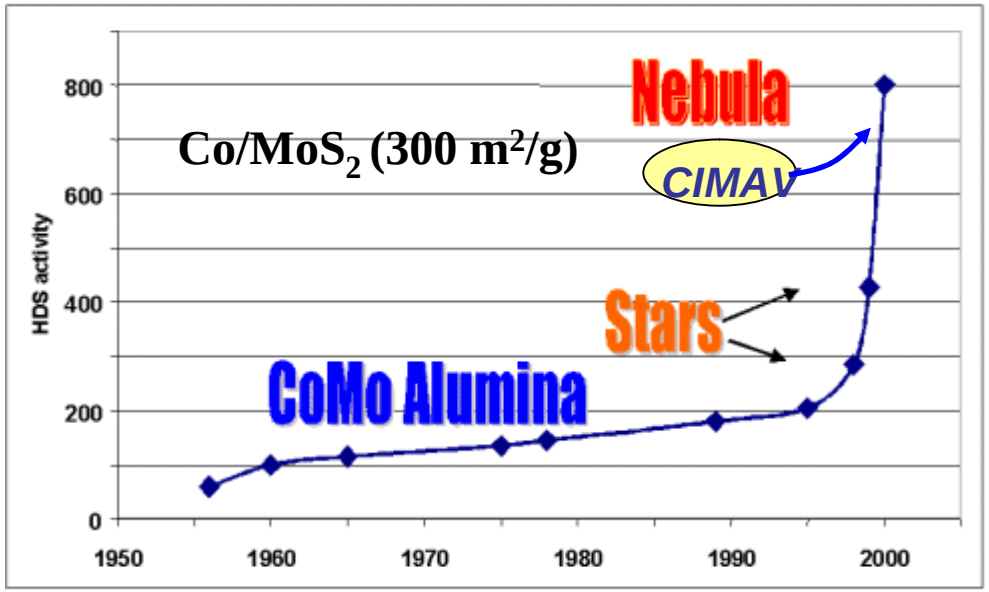
Intercalated clay (montmorillonite) with interlayer separation around 12 nm
Surface area around 550 to 610 m^2/g

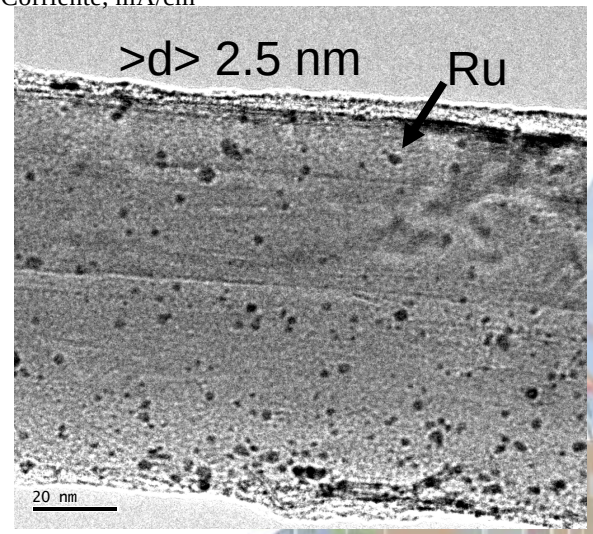
Catalytic Nanostructures for:

- *Sulfur removal from petroleoum*
- *Electro-catalysts tolerant to S and CO for fuel cells*



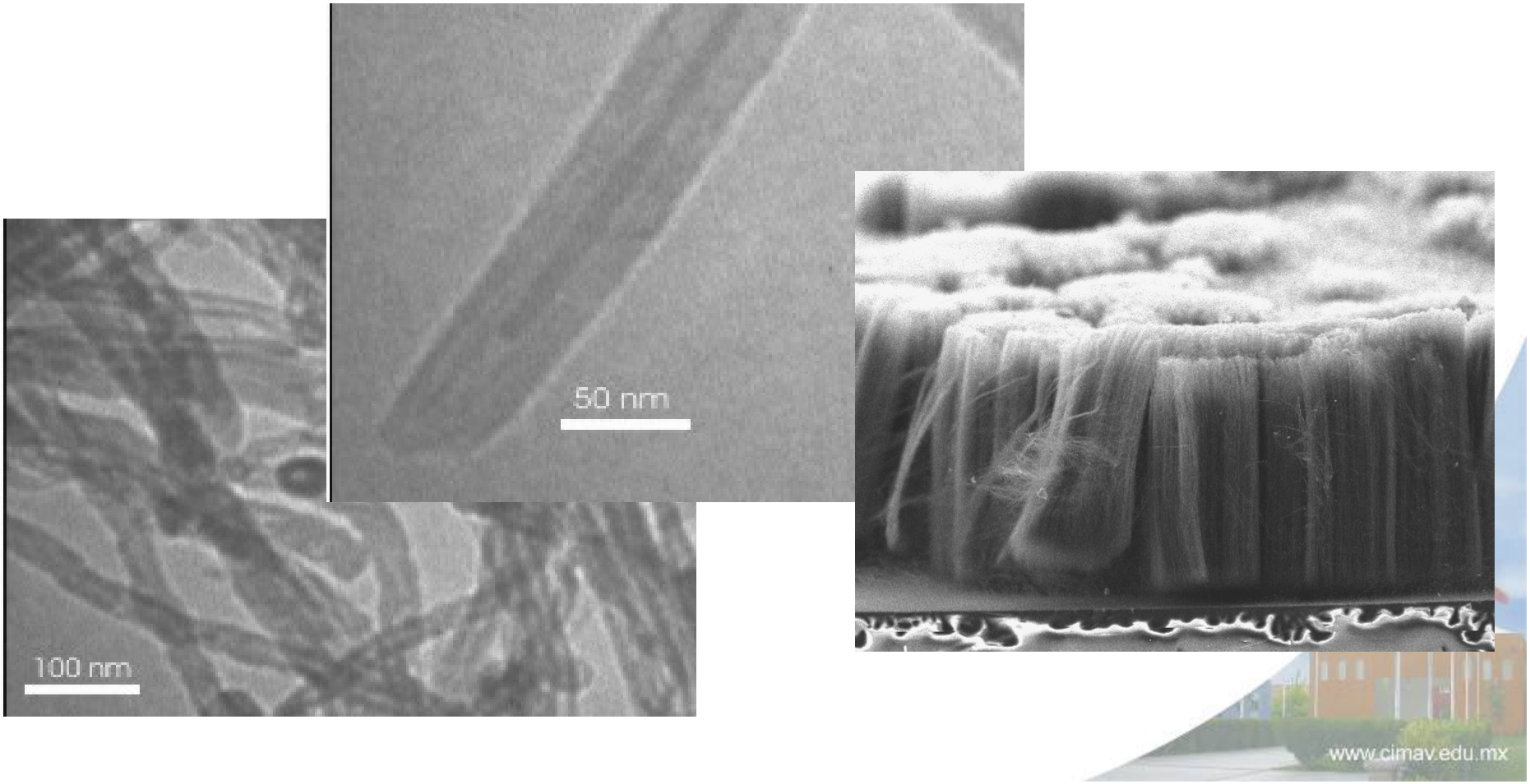




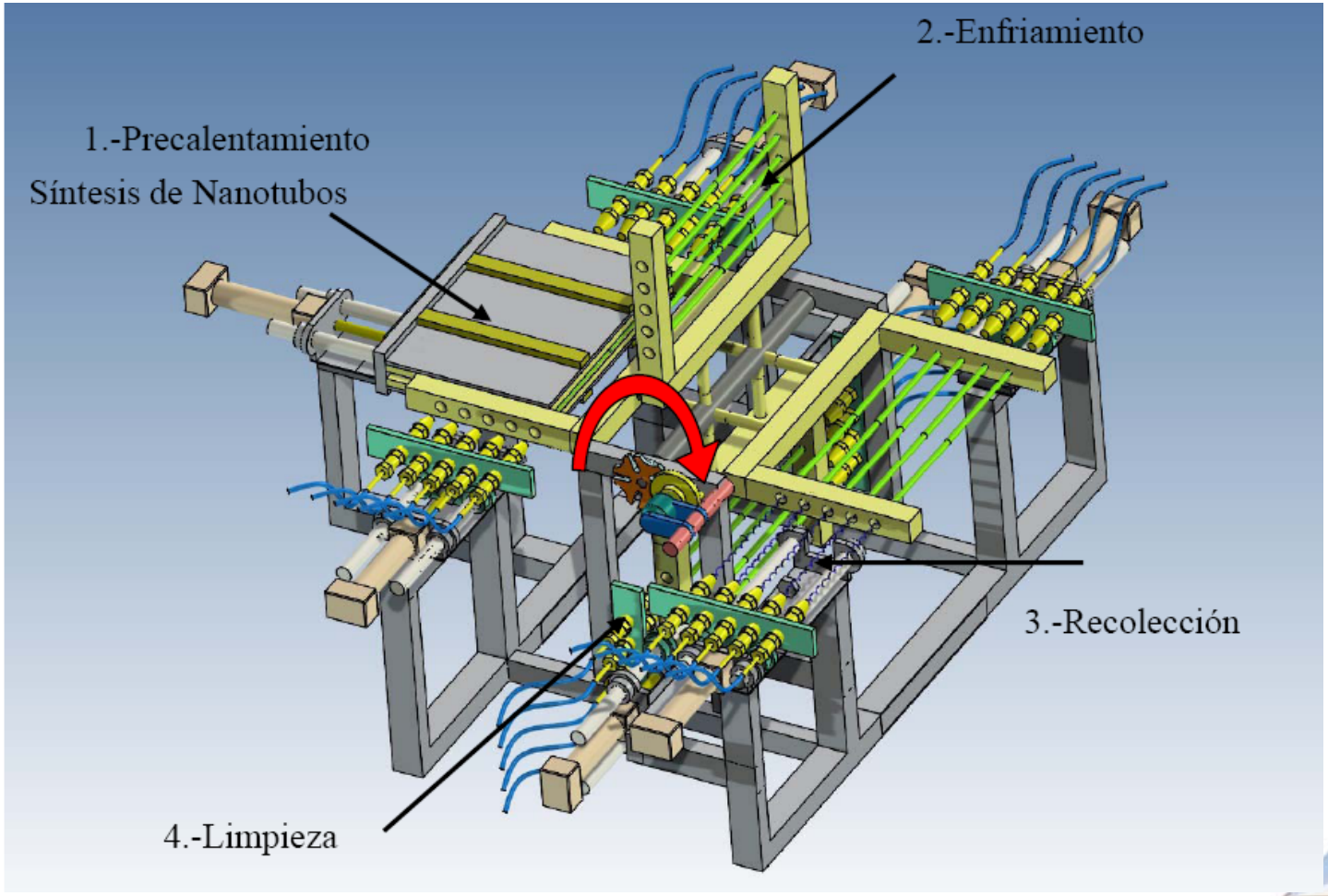


Synthesis of Multiwalled Carbon Nanotubes

Research in the scaling of laboratory process
Growth Mechanism of MWCNT by Spray Pyrolysis
Development of Applications



1st prototype under construction



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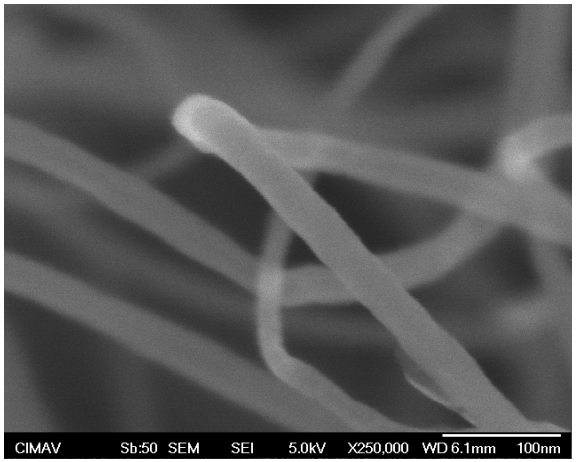
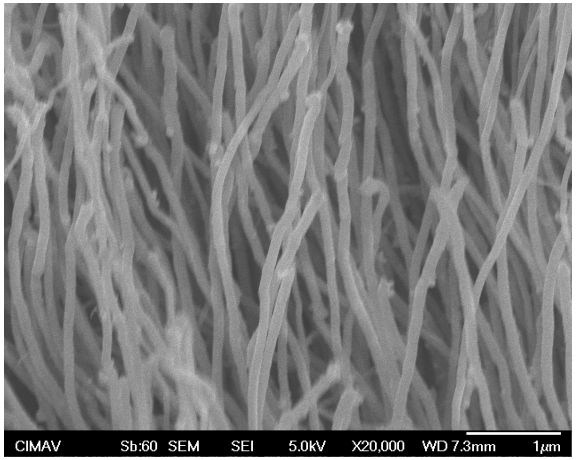
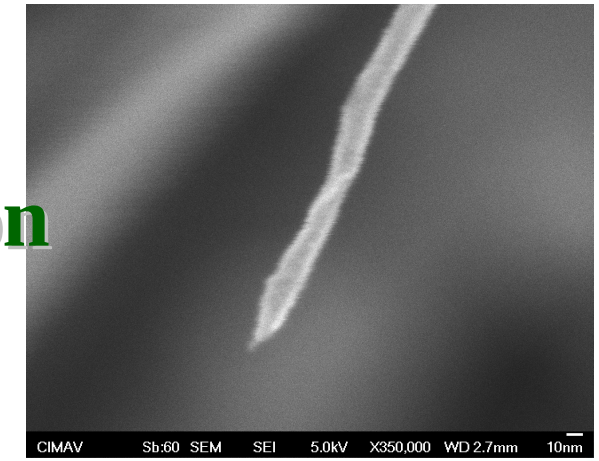
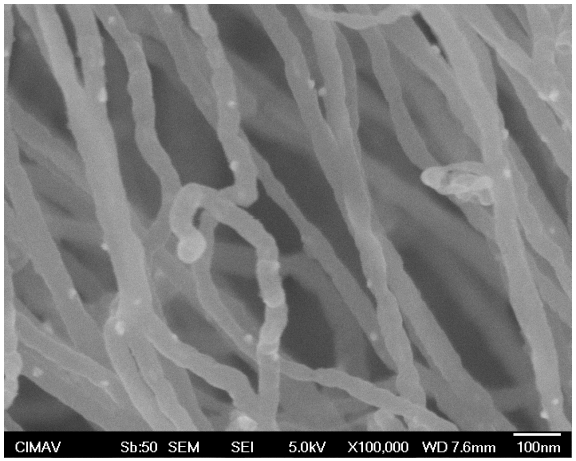
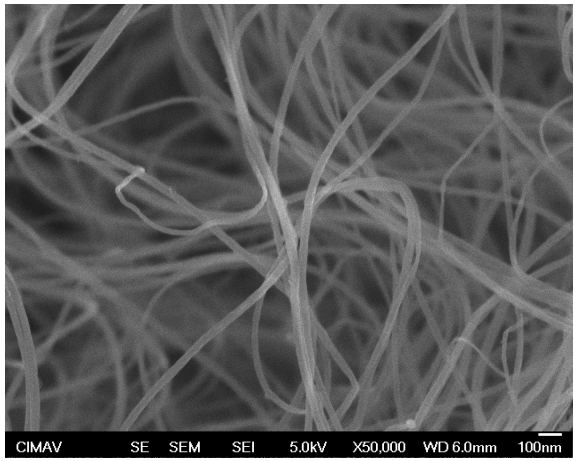
Study of variables in order to take full comand of production

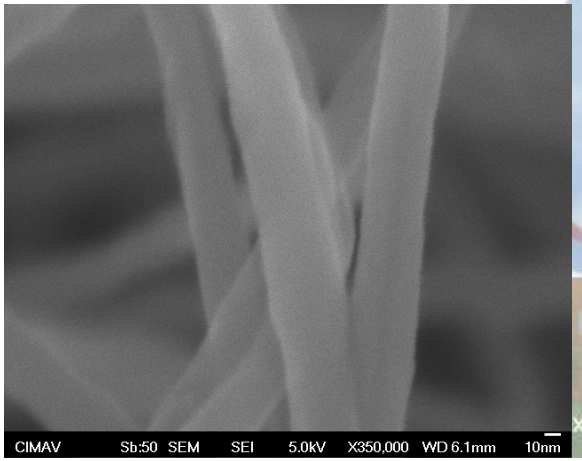




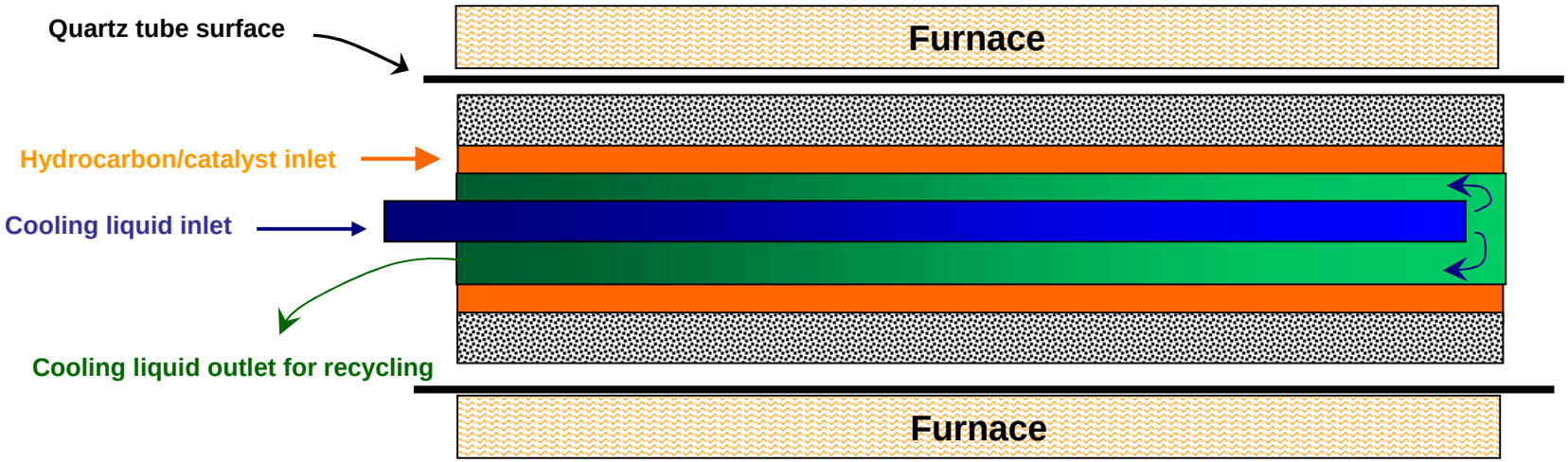




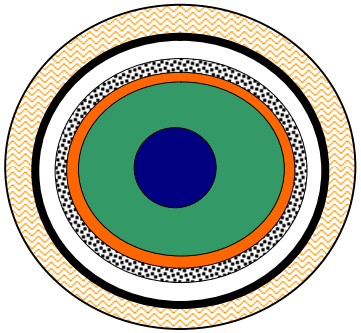




Design of new system to deliver hydrocarbon/catalyst to reactor



Side View



Transversal cut view

Mechanical Alloying Laboratory

TEM characterization of Al–C–Cu–Al_2O_3 composites produced by mechanical milling

Journal of Alloys and Compounds xxx (2006) xxx–xxx

Aluminum–graphite composite produced by mechanical milling and hot extrusion

Journal of Alloys and Compounds xxx (2006) xxx–xxx

Mechanical and microstructural characterization of aluminum reinforced with carbon-coated silver nanoparticles

Journal of Alloys and Compounds xxx (2006) xxx–xxx

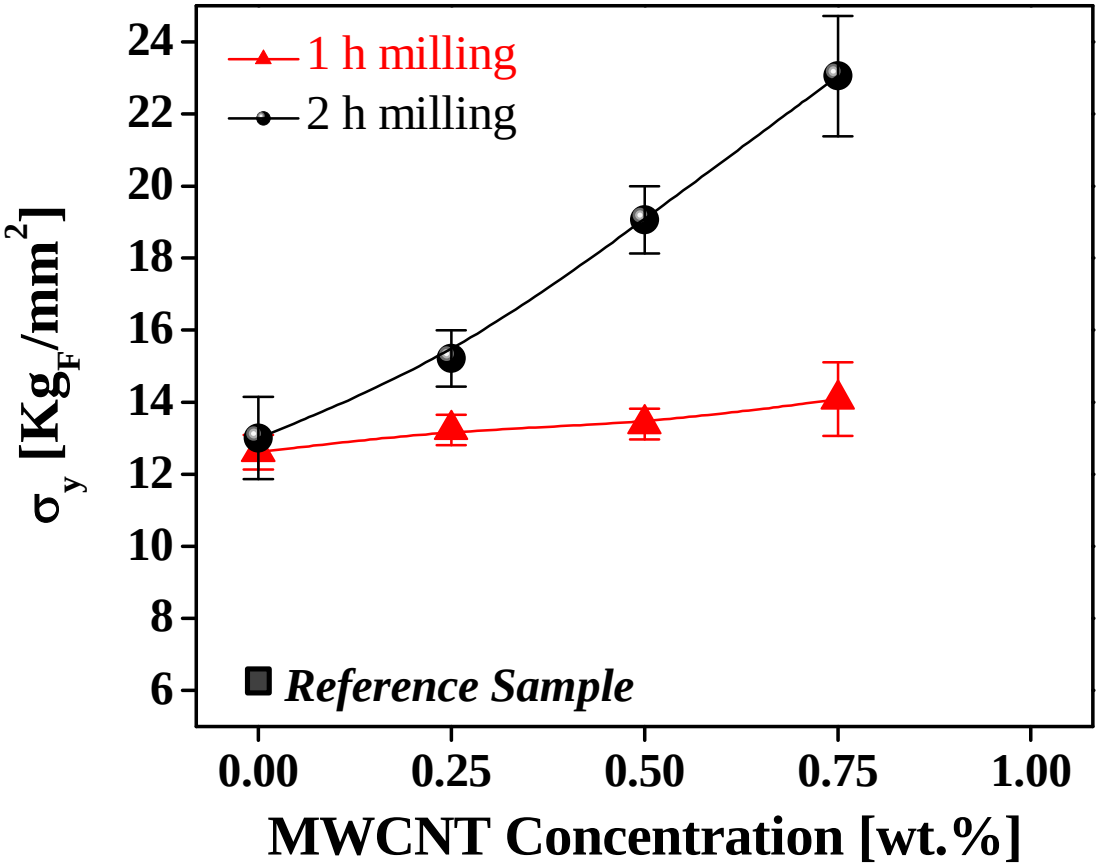
Electrochemical performance of hydrogen evolution reaction of Ni–Mo electrodes obtained by mechanical alloying

International Journal of Hydrogen Energy 29 (2004) 1141–1145

Materiales compuestos a base aluminio-nano tubos de carbono y su proceso de fabricación

Mexican Patent request ***NL/A/2004/000098***

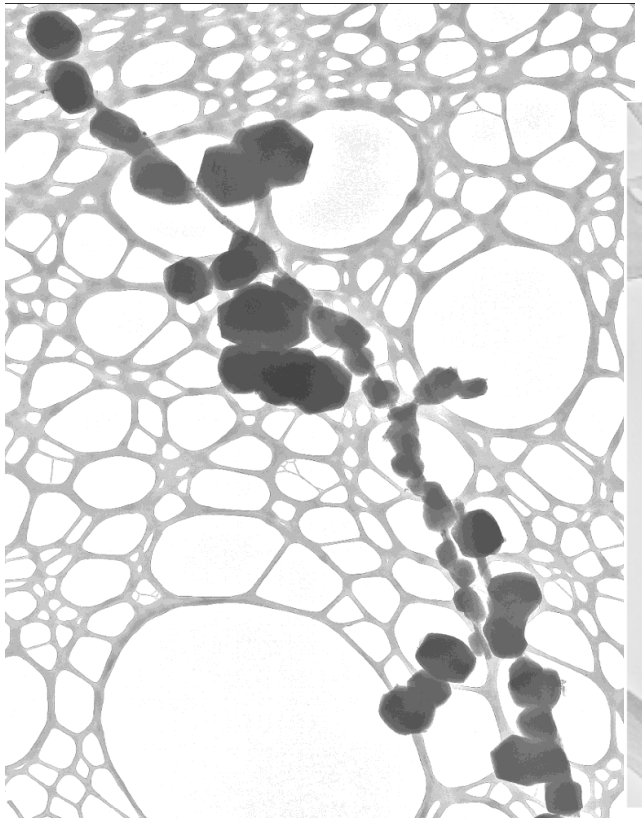
Aluminum-MWCNT Composites

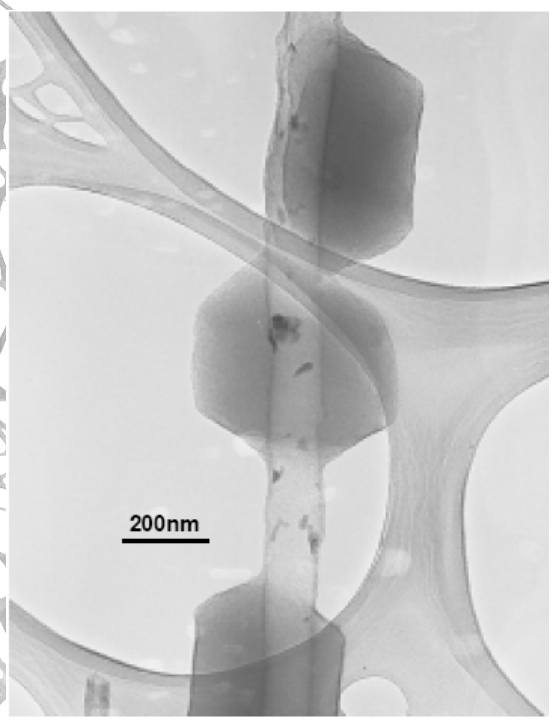


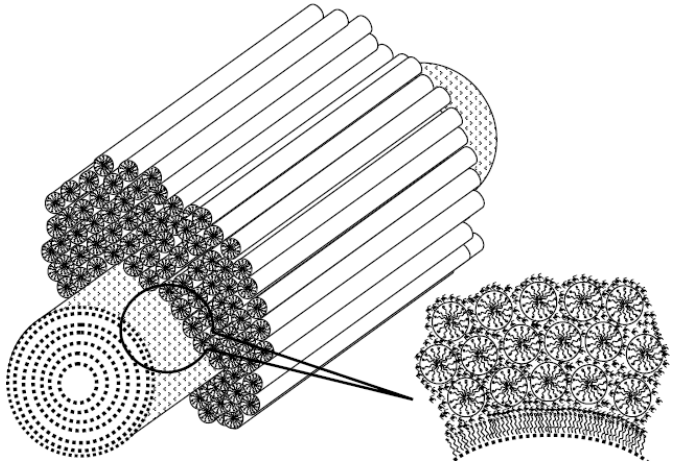
Yield strength on microcomposites as a function of MWCNT content

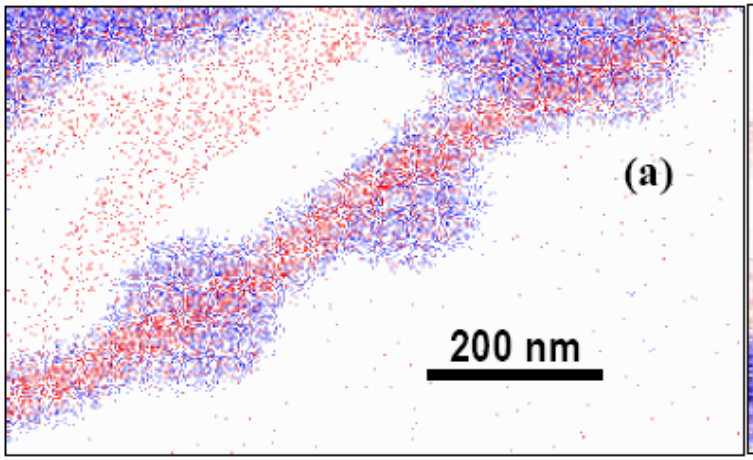
Dr. Roberto Martínez Sánchez

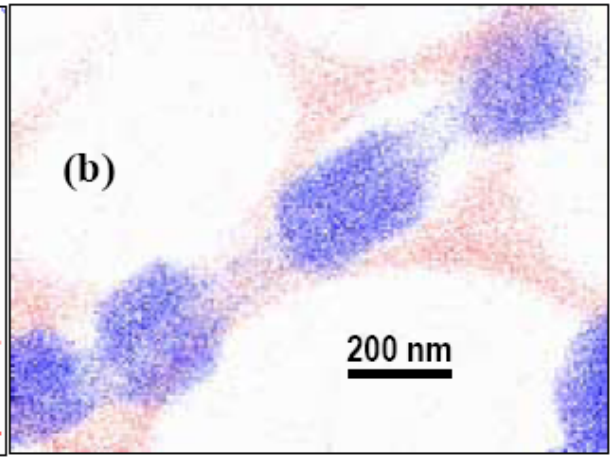
Novel Meso/Nanoporous Materials for Application on Catalysis Sensor, Gas Adsorption….



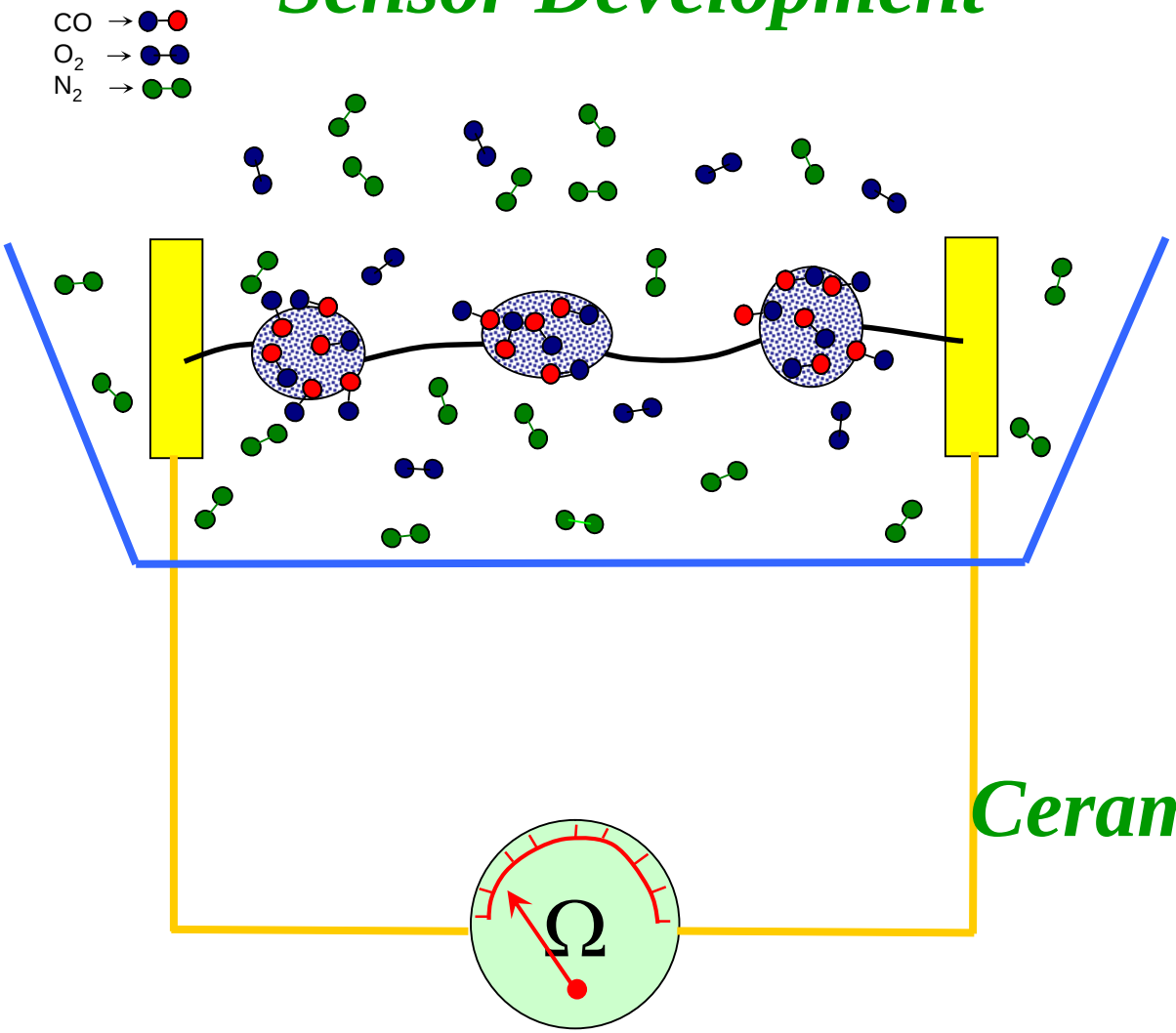


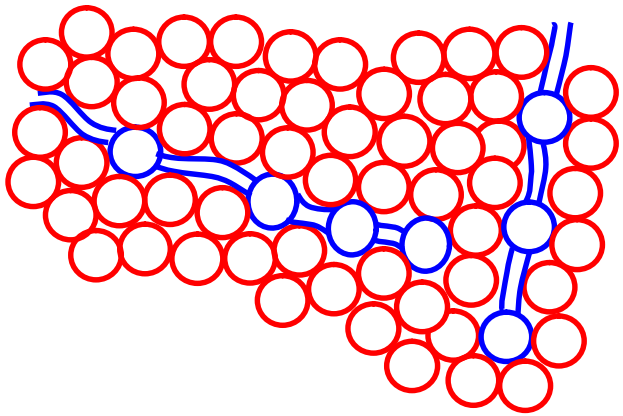






Sensor Development





Ceramics Reinforcement

Photocatalysis

Modification of TiO_2 to improve applications and develop new ones

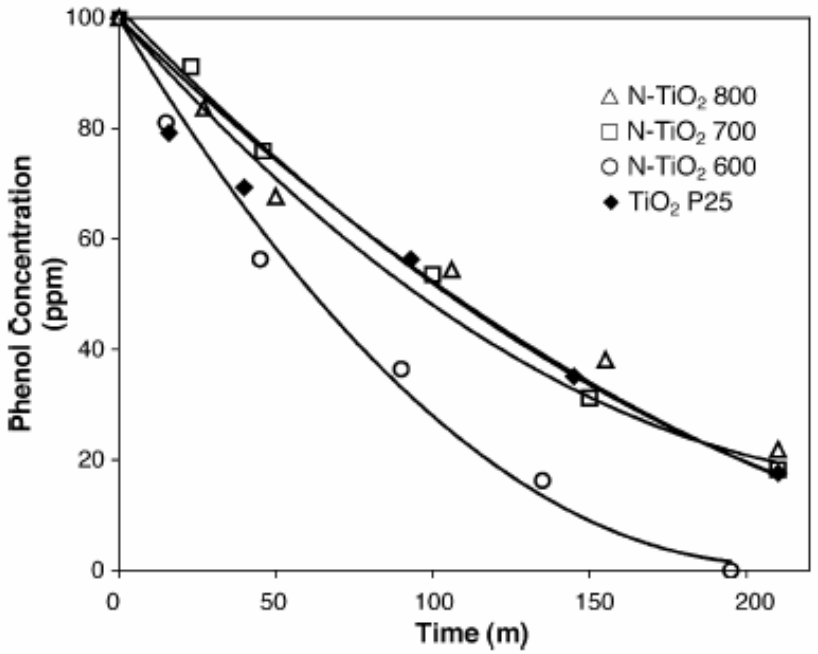
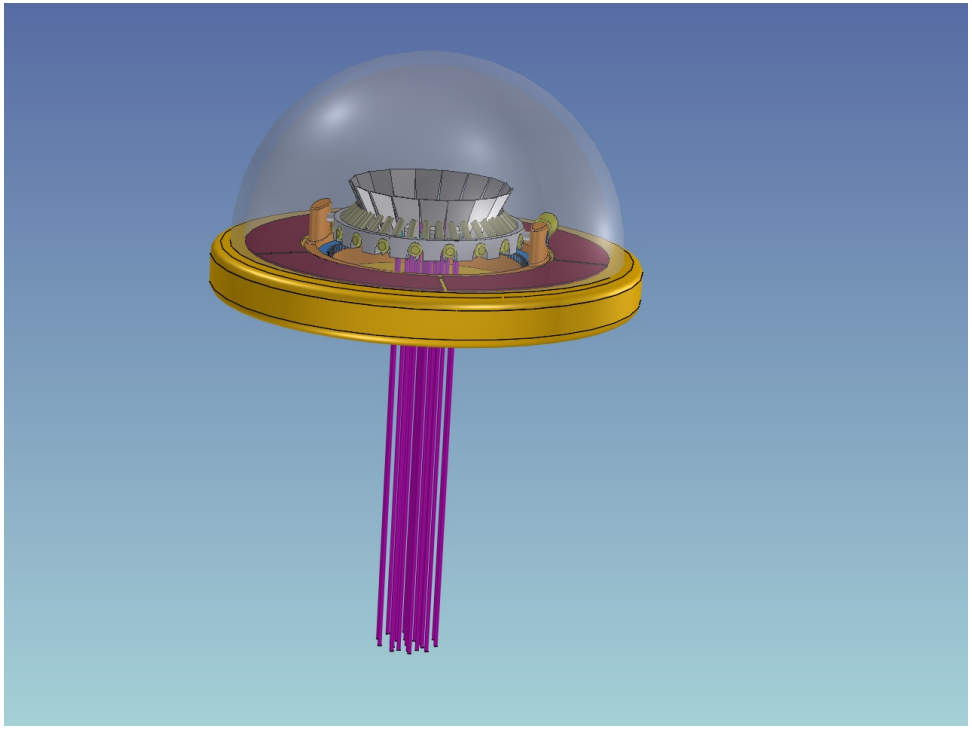


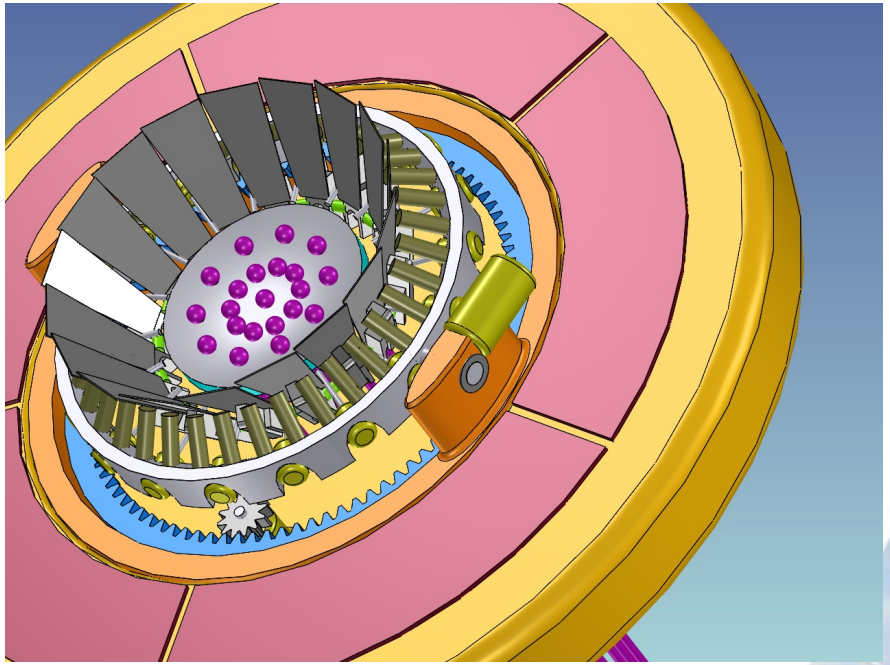
Fig. 4. Photocatalytic phenol degradation by the nitrogen doped TiO_2 and unmodified TiO_2 Degussa P25.

Photocatalytic Jellyfish like reactor

-Design of long-life Nanostructured photocatalyst to work under visible ligth

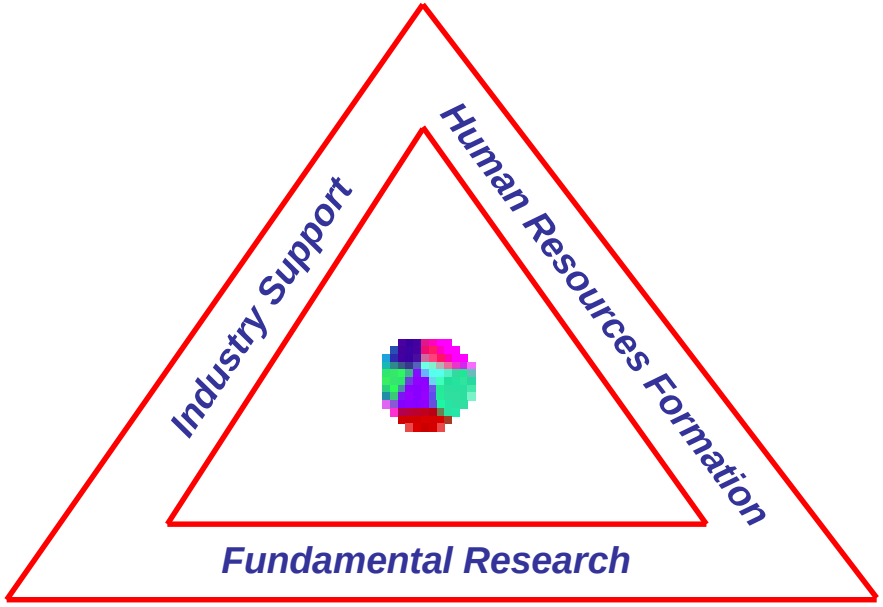
-Desing of low cost driver ligth into optical fibers





-Work during all sunligth hours

-Travel path can be programmed



Thanks for Your Attention!